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# Color and photography in the restorative dentistry. A brief communication about color temperature, dental color and the use of light and photography in dental practice

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***Abstract***

***Relevance.*** *Optical properties of dental tissues can be captured by photography, considering the characteristics of the light sources. Therefore photography might become a way to communicate the color and the characterizing aspects of the teeth, reducing the misunderstandings between the dental practice and the laboratory in the project of dental restoration.*

***Purpose.*** *To illustrate some ways of using the current photographic technology to document teeth color correctly, and to be able to communicate it without misunderstandings and to replicate it in a simple way.*

***Materials and methods.*** *The photographs were taken using Nikon D500 digital camera, Nikkor 60 mm 2.8 macro lens, Nikon SB-700 Speedlight flash, natural light diffuser and a reflector panel.*

***Results.*** *Correct precautions in execution of the photographs make it possible to obtain more realistic images and to limit defects in the perception of color, due to the incorrect use of the light sources.*

***Conclusions.*** *Well executed photograph makes it possible to obtain high quality images that can be evaluated in the project of a restoration and in the communication of teeth color and shade, and repeatable color evaluations, although the exact rendering of the color in digital images still has a slight discrepancy between images and natural objects. The visual method is more subject to variables instead.*

***Keywords:*** *Tooth color, tooth shade, photography, photographs, spectrophotometers.*

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## INTRODUCTION

The human eye is able to see colors that belong to the visible spectrum (between 380 nm of red and 760 nm of purple). The color seen is the radiation that the object returns, that is complementary to those that are absorbed.

Optical properties of dental tissues (translucency, opalescence and fluorescence) depend on enamel and dentin, on how these tissues overlap and diffuse light. The translucency of the incisal edge makes it possible to observe the characteristics of the dentinal structure below.

The hue and the chroma are more intense in the cervical regions of the teeth than in the incisal ones.

The appearance of the tooth surface [1, 2] is determined by the horizontal incremental growth lines of the enamel and the vertical developmental lobes of the tooth. This affects the value of the enamel and gives to the teeth a natural appearance. In older teeth the thickness of the enamel decreases and the surface texture of the tooth is less evident. This reduces the value and changes the light reflection: in an old tooth the reflection is more specular, instead in a young one it is more diffused. Over the years, the thickness of the enamel of incisal margins and cusps physiologically wears, because of the daily masticatory activity. The natural difference in color and shade that exists between maxillary incisors and canines will progressively decrease as a function of increasing age [3].

In the middle third and in the cervical third of the tooth, the brightness is generally greater than in the incisal third. In fact, this tends to be more transparent and to absorb more light [4].

The color temperature quantifies the shade of light coming from a source into a temperature expressed in Kelvin (K). The color of an object changes in relation to the light source that illuminates it, and it depends on the different hours of the day, periods of the year and atmospheric conditions.

Although modern technology makes it possible to objectively evaluate color, its perception remains extremely subjective and variable.

The best conditions for finding natural teeth color and shade include the exclusion of external light and a controlled use of light sources that should have temperature between 5000-6000 K. Bright colors can change the perception of color: interior decoration, clothing or makeup should be soft or absent. For example, a red lipstick that is too intense, could make the teeth appear with shades of green, which is the complementary color [5].

The eye perceives better the variations of hue and chroma rather than those of lightness [6]. Taking too long to find the correct tooth shade could strain the eye, therefore the color could be mistaken. It could be better to take a few seconds.

Photography plays a fundamental role in dental practice, as it make it possible to take high quality images and close to the natural tooth. The most important components of the camera, in dental practice, are the lenses and the flashes. Because of the short focal lenght between lens and patient, the most suitable lenses could be the macro lenses, because they can correctly focus on dental arches at a distance of about 10 cm.

Flash light in dentistry should give the tooth three-dimensionality and emphasize the details of the surface

*From Fig. 1 to Fig. 3.* **Three examples of the same photograph realized with different white balance (in order, natural light, warmer light and cooler light) in female 29 years old subject. The perception of hue and chroma of the teeth changes significantly**

and the characteristic aspects of the tooth. Flashes with direct or diffused light could be used [7].

There are some filters that make some aspects of the tooth stand out better. For example, polarized light filters emphasize the white opaque component of the enamel by blocking the reflected light and reducing or eliminating the brightness of the image. In this way, the dentinal body could be identified more clearly [8].

Digital photo editing programs make it possible to correct the color temperature with white balance, so that objects appear natural and similar to the real ones, taking into account the color temperature of light sources at the time of shooting.

Spectrophotometers or intraoral scanners can help identify hue, chroma and value with a margin of error lower than the visual method [9, 10], even if they are unable to identify fluorescence or other characteristic aspect of the tooth.

## MATERIALS AND METHODS

The following photographs were taken using Nikon D500 digital camera, Nikkor 60 mm 2.8 macro lens, Nikon SB-700 Speedlight flash, natural light diffuser and a reflector panel.

## CONCLUSION

Well executed photograph makes it possible to obtain high quality images that can be evaluated in the project of a restoration and in the communication of teeth color and shade, and repeatable color evaluations, although the exact rendering of the color in digital images still has a slight discrepancy between images and natural objects. The visual method is more subject to variables instead.

A good approach could be the evaluation of color on several fronts, without been limted by a single method. Aids such as natural light lamps are useful in determining the correct color. Experience and clinical practice allow the dentist to recognize the shade of color more quickly and easily, and the repeatability of the same light conditions during the color relief could give high precision in the determination of the correct color for a personal restoration.

*Fig. 4.* **Black and white photography emphasize the value of enamel (female 29 years old subject)**

*Fig. 5.* **Noticeable progression of hue and chroma from maxillary incisors to canines, premolars and molars in female 29 years old subject**

*Fig. 6* **and** *Fig. 7:* **red lipstick gives a light gray shades to the gingival tissue (female 24 years old subject)**

*Fig. 8* **and** *Fig. 9:* **red lipstick changes color perception; in** *Fig. 9***, the teeth have a very light green shade and the skin seems lighter also (female 56 years old subject)**

*Fig. 10* **and** *Fig. 11:* **differences in surface texture between a male 15 years old subject (left) and a male 35 years old subject (right); the surface texture is more evident in the younger subject**

*Fig. 12.* **Noticeable reduction of the natural difference in tint and chroma between the central incisors and the canines in a female 79 years old subject; also, mirror reflections due to the progressive reduction of the thickness of the enamel are evident**

Communication and repeatability are fundamental aspects in this sector, therefore it might be interesting to develop indications in the future that can allow to drop personal interpretations of color, to achieve a safer and simpler aesthetic success.

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*All the photographs were taken by Salvatore Chiazzese.*

*Conflict of interests:*
*The authors declare no conflict of interests.*

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